BASEWIDE ENERGY STUDY
FORT GREELY
ALASKA

VOLUME 1
EXECUTIVE SUMMARY

PREPARED FOR
DEPARTMENT OF THE ARMY
ALASKA DISTRICT CORPS OF ENGINEERS
CONTRACT NO. DACA 85-80-C-0010

PREPARED BY
ENERGY CONSERVATION SERVICES
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714

APRIL 1982

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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Planning Office
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PREFACE

The final report of the Basewide Energy Study program consists of three volumes. The Executive Summary (Volume 1) highlights and summarizes the results of the study and concludes with an Energy Plan. The Technical Volume (Volume 2) includes the Executive Summary (serving as an introduction and summary), and also contains the technical discussion and justification of the recommended projects and plans. The Appendices (Volume 3) contains detailed calculations and supporting documentation.

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Section 1
INTRODUCTION AND SUMMARY

1.1 PURPOSE

In response to the Nation's commitment to energy conservation, the Army Corps of Engineers (CoE) has contracted with Grumman Aerospace Corporation to perform a Basewide Energy Study of three forts in Alaska. The purpose of the study is to produce a systematic plan of improvement projects to reduce energy consumption.

1.2 SCOPE

The contract (No. DACA 85-80-C-0010) includes studies at Fort Wainwright, Fort Greely, and Fort Richardson. Each fort is covered by a separate report.

This report covers the Phases I & II Increment A for 51 buildings. Phase III was excluded from this contract. Increment B study was limited to Steam Distribution and EMCS, the Central Heat and Power Plant (CH&PP) having been studied earlier by another contractor. Increment F & G studies are also covered by this report.

In this report, current energy usage at Fort Greely is analyzed, and a set of energy conservation opportunities identified. These are defined, evaluated, and presented herein as a preliminary plan for increasing energy efficiency.

This report is divided into three volumes: an Executive Summary, a Technical Volume, and a volume of supporting documentation appendices.

The main features of this report are the tables of recommended energy conservation actions. These actions are further described in the technical volume. The detailed engineering analysis supporting these conclusions can be found in the appendix volume.

1.3 DESCRIPTION

Fort Greely is an Army post located above the Delta River near Delta Junction, Alaska, 90 miles southeast of Fairbanks. Figure 1-1 shows the 106 buildings of the post covering 1.26 million sq ft on the main post, and a 45,707 sq ft hangar at the airfield to the north. There are other temporary buildings, most of them shut down, and other off-post facilities that are not included in this report. Most of the main post buildings are of permanent construction and were constructed between 1950 and the mid 1960s.

There are two oil-fired central heating steam plants; one, H-606, serving the main post with heating steam distributed through 4 miles of supply piping; and the other, H-T-101, serving the hangar and some miscellaneous buildings at the airfield. Electricity is provided over the Golden Valley Electric Association (GVEA) utility tie line from Fort Wainwright. A diesel electric generating plant, which had been in use prior to 1979, is on standby in the power plant.

The main post was fully utilized at the time of this survey. The hangar area (Old Fort) was partially utilized at the time, with occasionally greater temporary utilization by visiting units on training maneuvers.

1.4 OVERVIEW

The following is a summary of the basic findings of this study, including the energy conservation strategies leading to the energy conservation plan. Implementation of the recommended energy conservation projects of that plan and the new CH&PP as recommended could reduce the source energy consumption of Fort Greely by 48% of the FY'80 baseline consumption. The FY'84 projected cost of that FY'80 energy could be reduced by 86% or $4.8 million.

1.4.1 Central Heat and Power Plant (CH&PP)

The analysis of basewide energy usage shows that approximately 43% of the total input energy is consumed in the Fort Wainwright CH&PP, for generation of Fort Greely electricity, and 10% in H-606

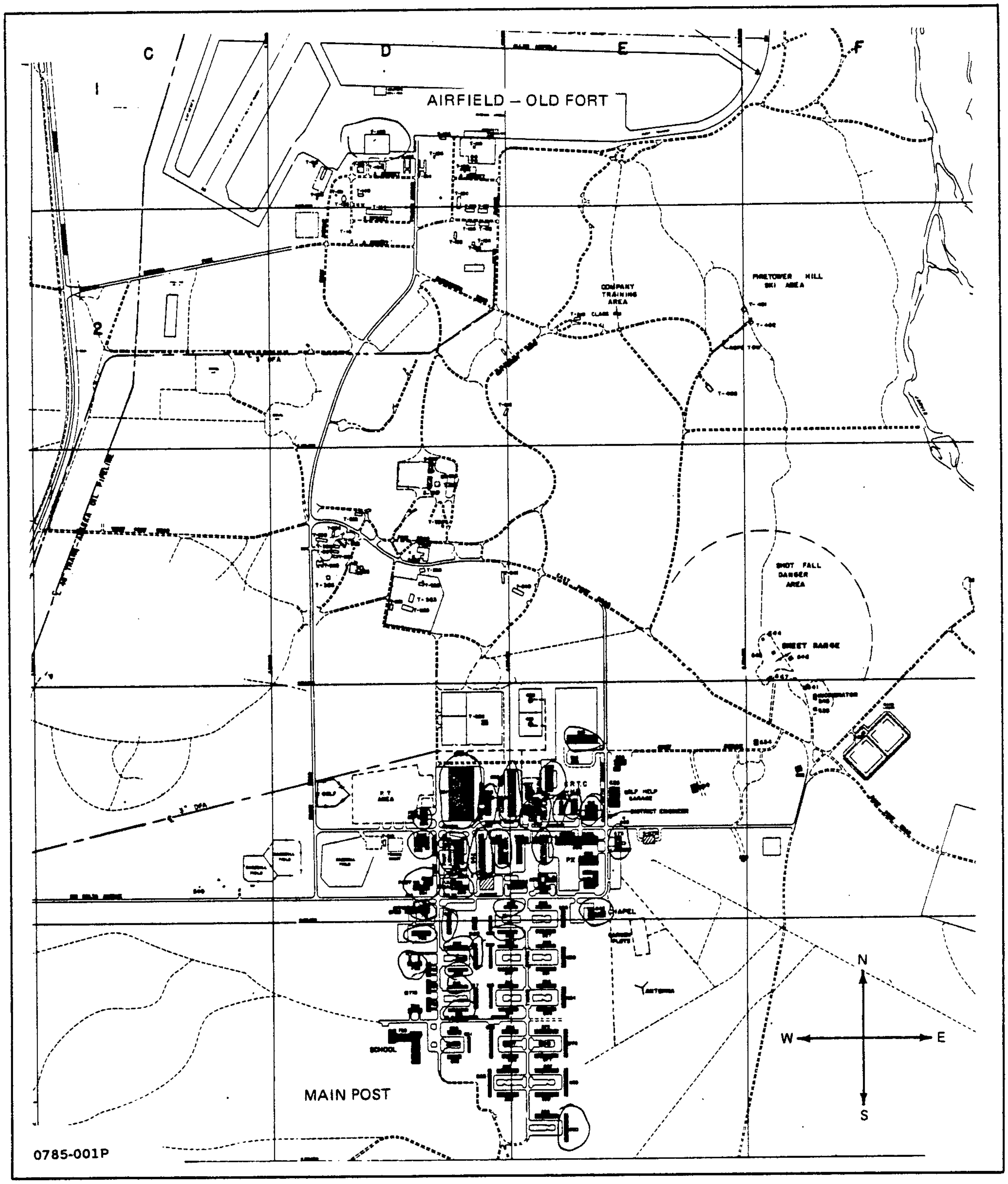

Fig. 1-1 Fort Greely Site Plan

Central Heating Plant for heating steam at Fort Greely. This finding establishes study of these CH&PPs as most significant areas for potential savings, since a small percentage of improvement can have a large savings impact. Analyses have shown that although coal is used, the cost for marginal electricity is relatively high at Fort Wainwright. However, for equivalent energy, the oil cost at Fort Greely is 5.7 times as high as coal cost with future projections widening the gap. This leads to the conclusion that an Increment D study should be done to evaluate a coal fired CH&PP at Fort Greely as an alternative to the current situation.

1.4.2 Steam Distribution System

Associated with the steam distribution system is the loss of approximately 4% of the total site energy. Conduction losses from the distributed system are excessive through uninsulated and minimally insulated piping. In the summer, base load losses approach steam user requirements; significantly reducing system efficiency. Increased insulation is recommended.

1.4.3 Buildings/Users

Buildings and other end users account for approximately 37% of the total site energy. Building envelopes are, in general, well insulated with the major exception of non-housing military buildings, basements, and floor slab edges. Despite storm windows, insulation, and improved heating controls, energy consumption is higher than would be predicted by building thermal analysis modeling. This is most apparent in summer months. Much of this higher consumption is attributed to an overheating problem caused by excessive infiltration through windows opened to correct the overheating. Once the window is opened, it tends to remain open even when the outside temperature drops. This occurs because local heating controls react to provide additional heat to maintain comfort in the space, and, therefore, there is no incentive on the part of the occupant to close the window.

The corrective strategy is to minimize the overheating problem and keep the windows shut while heat in the building is on. The overheating results from various combinations of several sources such as supply temperatures set too high in air handling systems, radiation from radiators without controls or with control failure, radiation from building steam piping and hot water distribution systems, and radiation from uninsulated components in mechanical rooms. These heating energy inputs are superimposed on basic "natural" heat loads from people, solar, and electrical components adding up to a requirement for cooling rather than heating to maintain building comfort for almost half of the year. Additional piping insulation along with additional control modifications are recommended to correct this situation.

Ventilation systems are another area where large savings opportunities exist. There is evidence of excessive outside air volume, especially when variable occupancy is considered. There is also evidence of simultaneous heating and cooling, as well as the overheating problem mentioned earlier. Solutions vary from control resets to system modification or replacement. Fan speed reductions and high-low fan speed rates offer valuable electrical savings in addition to steam savings.

Improvements in lighting efficiency throughout the Fort and reduction of head bolt heater use will also reduce electrical consumption.

Section 2
CURRENT ENERGY USAGE

2.1 ENERGY USAGE HISTORY

Substantial progress was made in energy conservation at Fort Greely between FY'75 and FY'80 (the time frame of this study), culminating in a 10.9% reduction in KWH of electricity and a 27% reduction in heating oil. The source of these savings is believed to be operational changes and Energy Conservation Investment Projects (ECIPs). These ECIPs may also be responsible for some FY'80 additional savings. Subsequent to the study, in 1981, it has been noted consumption increased for reasons unknown.

Source energy reduction was negligible, however, due to a transition from primarily diesel-electric generation at Fort Greely to all coal fired steam turbine-electric generation wheeled from Fort Wainwright. This is shown on the annual source energy apportionment in Figure 2-1. The diesel-electric generation line was plotted directly from Fort Greely records and represents a heat rate of about 11,812 BTU/KWH. The coal-electric apportionment was based on the Fort Wainwright Central Heating and Power Plant (CC&PP) analysis using a 19,000 BTU/KWH marginal heat rate and 1.29 ratio for the difference between Fort Wainwright output and Fort Greely input. This represents an apparent 29% wheeling loss. The overall heat rate for wheeled electricity used on this graph is 24,500 BTU/KWH.

The electrical energy source transition from oil to coal has been beneficial since it saves both oil consumption and cost. Oil cost is 5.7 times that of coal. The fact that this large saving has been made despite a nominal loss in thermal efficiency suggests that an opportunity exists for large additional savings if Fort Greely can be converted to a coal fired CH&PP with some cogeneration of electricity.

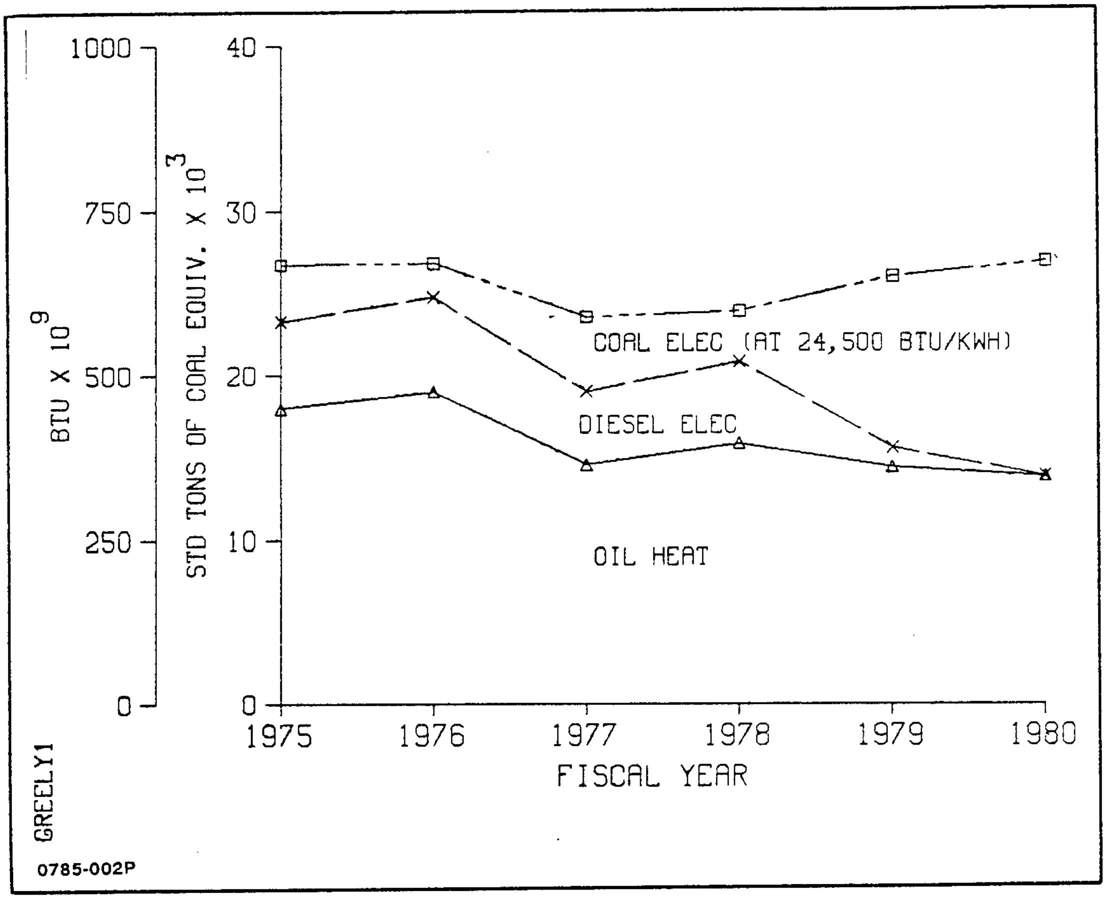

Fig. 2-1 Fort Greely Annual Energy Apportionment

2.2 ENERGY USAGE ANALYSIS

A top-down analysis was made of FY'80 energy usage at Fort Greely. Figure 2-2 shows an overall source energy apportionment of 47.8% to heat and 52.2% to electric. Of this total source energy, 82% is apportioned to end users at Fort Greely, 6% to steam distribution, and 12% to apparent electrical energy wheeling loss. The cost apportionment of Figure 2-3 shows that 85% of the total cost is for oil.

In Figure 2-4, a site energy apportionment of source energy shows that 42.6% of the energy is consumed at Fort Wainwright CH&PP in producing electric energy for Fort Greely. User steam is 34.2%, user electric 7.3%, and all distribution 6.4%. Heat loss reduction and

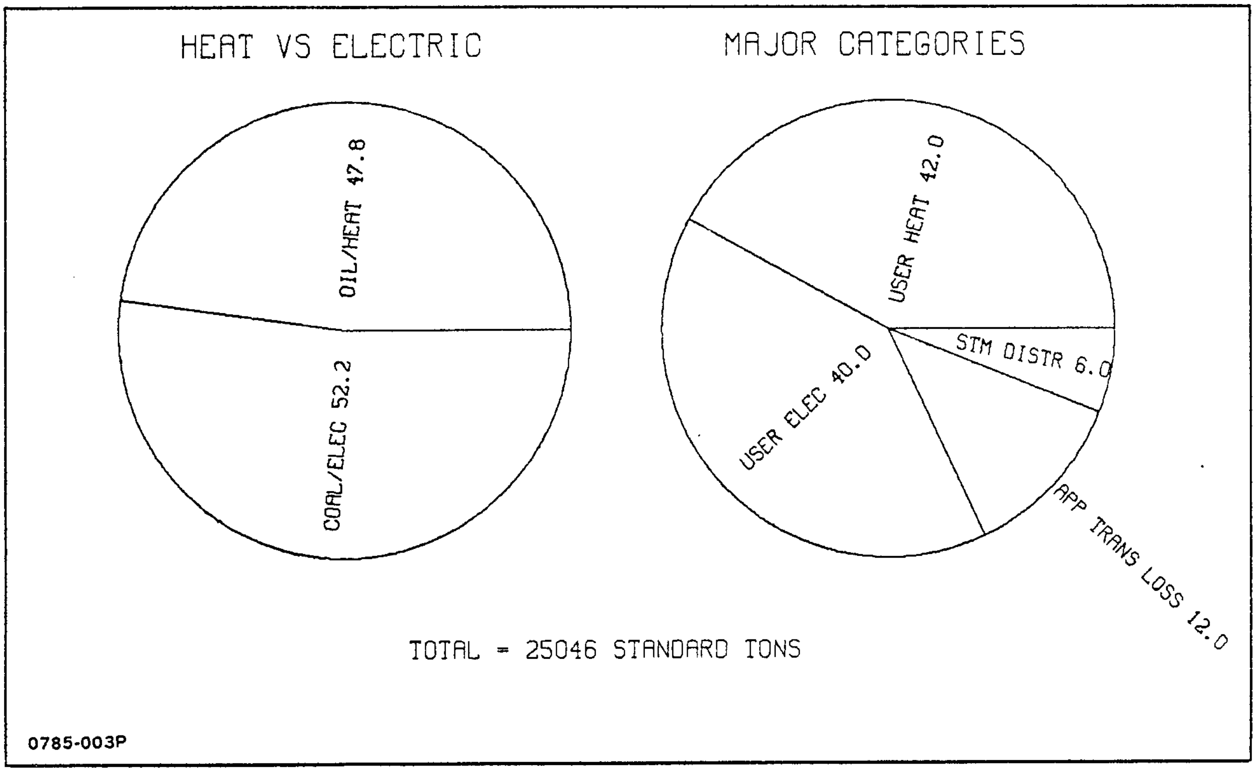

Fig. 2-2 Fort Greely FY'80 Source Energy Distribution

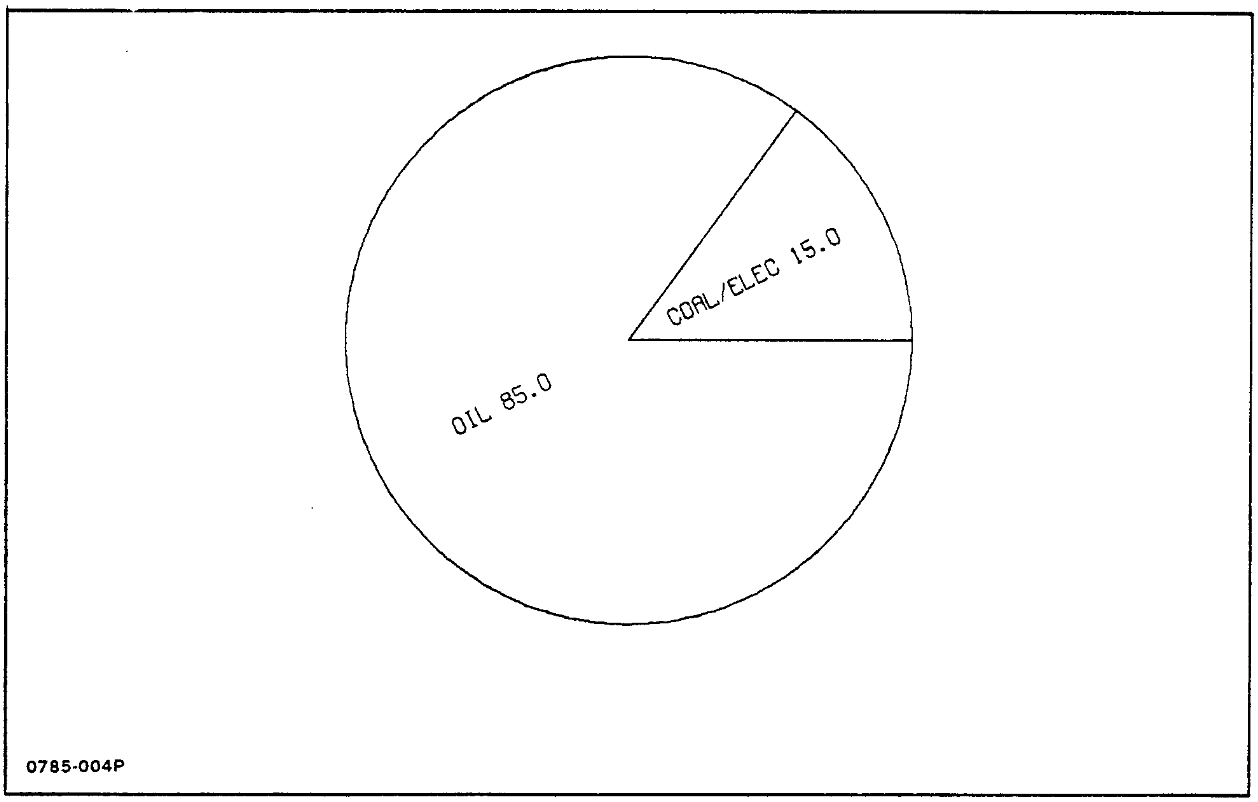

Fig. 2-3 Fort Greely FY'80 Source Energy Cost Apportionment

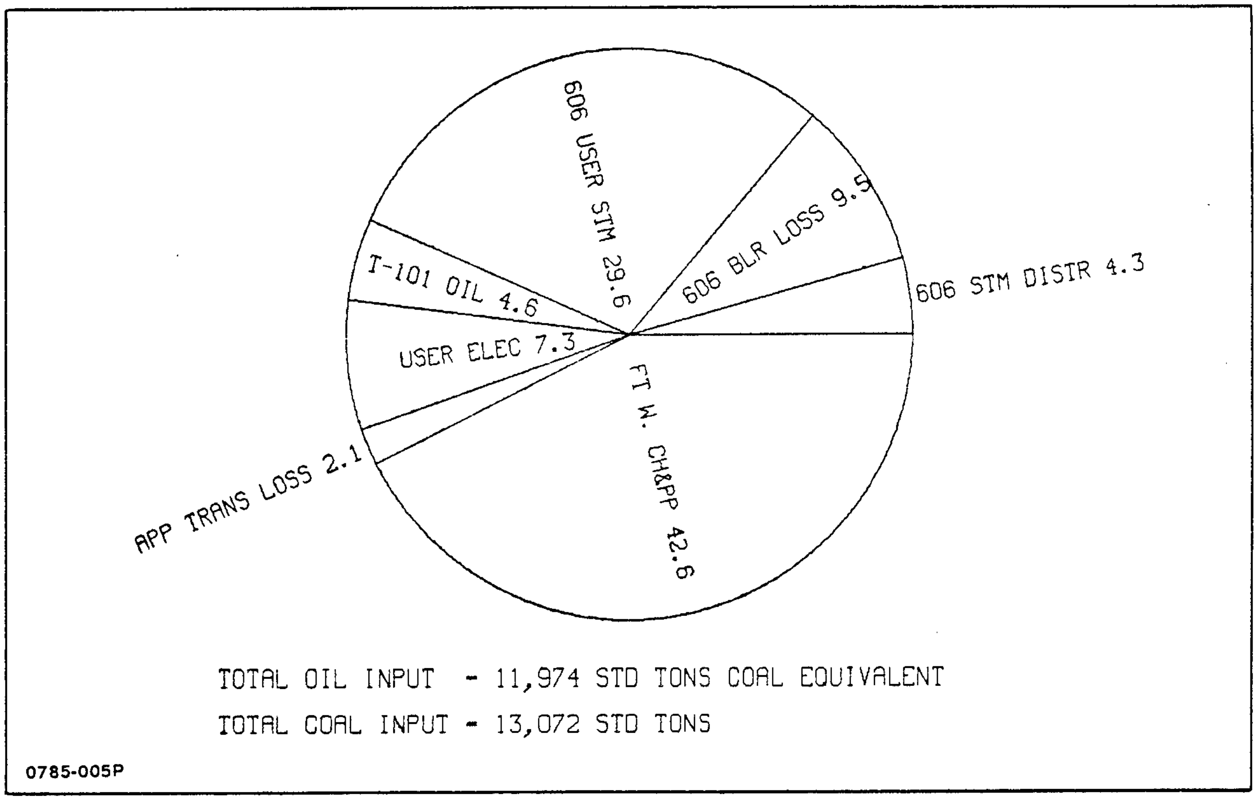

Fig. 2-4 Fort Greely FY'80 Site Energy Distribution

electrical usage reduction are the focus of conservation in these areas. The 7.3% for imported electricity has an effect greater than the number would indicate due to its impact on Fort Wainwright CH&PP efficiency. The importance of this is reflected in the 40% source energy apportionment for electric shown in Fig. 2-2. Considering only the cost factor, however, oil savings are 5.7 times as important.

Energy distribution on a seasonal basis is shown in Figure 2-5. This shows the very low efficiency associated with summer operations. It also shows the relative magnitude of boiler and condenser losses, fixed steam line losses, and an undefined area of user losses largely attributed to excess infiltration from open windows.

2.3 ENERGY PERFORMANCE

Facility and building energy performance is displayed on the Energy Index graph in Figure 2-6. Here, electrical performance in

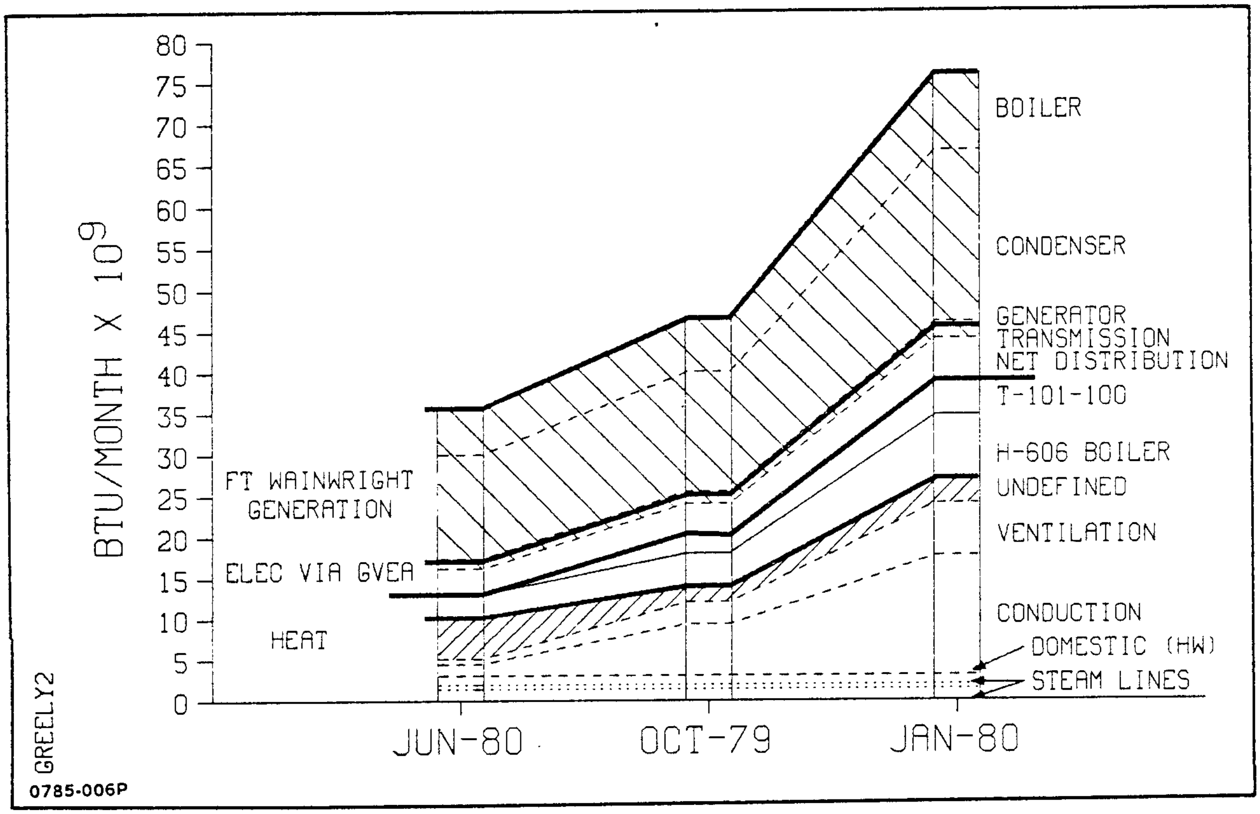

Fig. 2-5 Fort Greely Seasonal Energy Distribution

KWH/GSF-yr is displayed separately from heating performance in KBTU/GSF-yr. This eliminates the power plant efficiency variations from affecting comparison between various user buildings and facilities. The diagonals in Figure 2-6 represent lines of constant source energy if heating and electrical energy are combined. Electrical energy for the constant source lines is computed at 11,600 BTU/KWH, an average utility power plant heat rate for the United States.

The Fort Greely facility (Plant 606 only) energy performance for FY'80 is shown near the top of Figure 2-6. To arrive at a net building average performance index (indicated as 606 site energy), boiler losses and steam distribution losses were factored out of the overall facility index. The net building site demand can also be compared with the theoretical building site demand for sample buildings as derived by building analysis. The building samples approximated attainable target performance for most of the building area at Fort

Greely. This target has not been achieved, due, in large part, to an inability to reduce building heat input to the level of building heat demand based on actual insulation and ventilation requirements. Therefore, the overheating of buildings, and the consequent use of excess ventilation to compensate for it, is presented as a valid hypothesis leading towards saving energy.

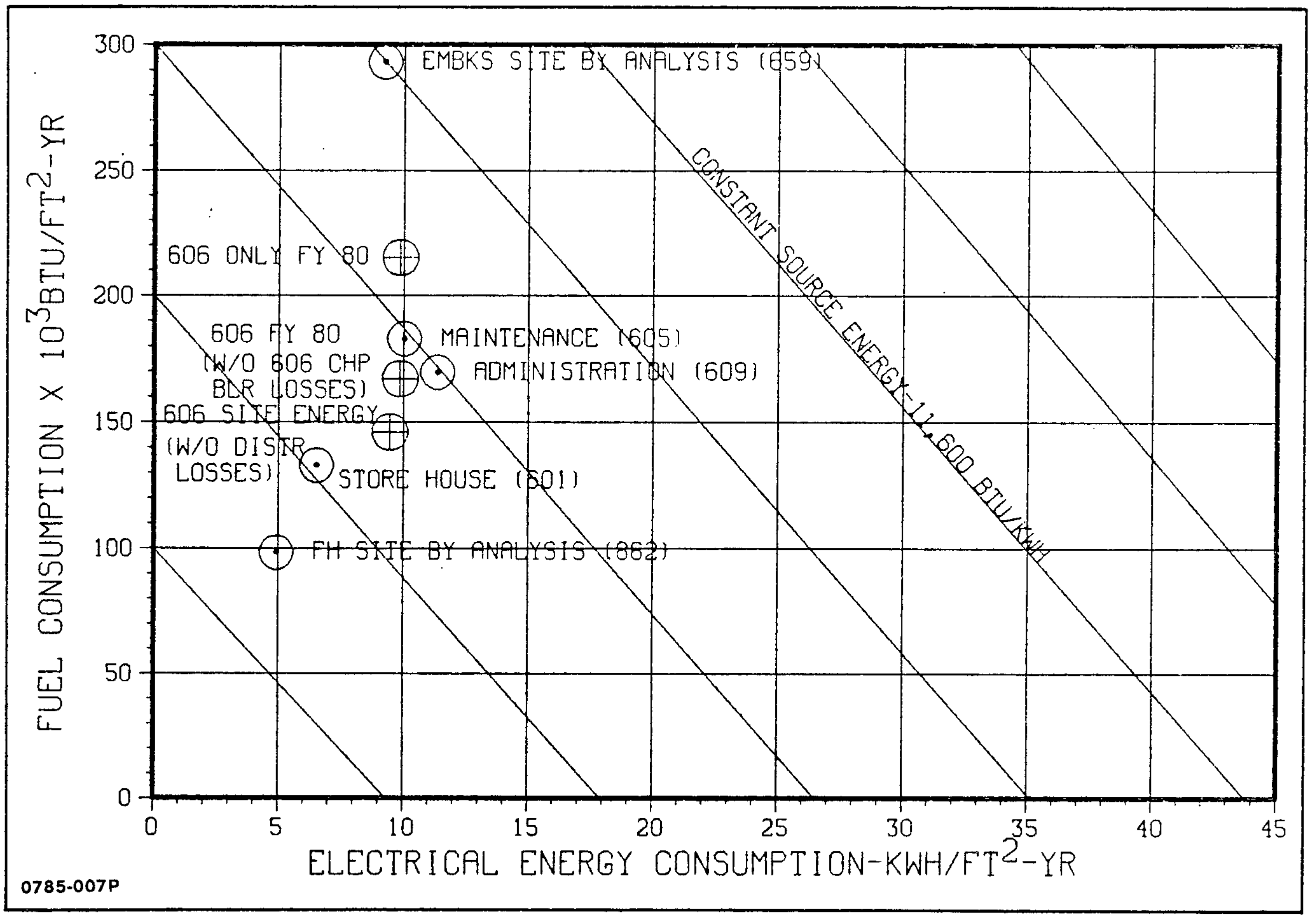

Fig. 2-6 Fort Greely Energy Index - FY'80

Section 3
RECOMMENDED ENERGY PLAN

The primary purpose of this study is to develop the recommended energy plan presented in the tables of this section. Also included are amplifying statements explaining each of the items in the plan. Section 4, which follows, shows the energy impact of this plan. Further discussion of the items can be found in the technical volume with detailed engineering analysis including cost and savings estimates in the appendix volume.

There are five tables used to present the plan, one for each Increment of Study, and one summary table. They are as follow:

- Table 3-1 presents Increment A Building/User ECIPs
- Table 3-2 presents Increment B Distribution System ECIPs
- Table 3-3 presents Increment F O&M Recommendations
- Table 3-4 presents Increment G Projects which do not meet ECIP criteria
- Table 3-5 summarizes the overall impact of the recommended plan.

There are differences between this final recommended plan and the project lists published in the final report draft of February 1981. Major differences are as follows:

- Lists have been categorized into Increments A, B, F, & G as per direction.
- Some projects have been consolidated into groups to fit Increment A ECIP criteria in accordance with established practice.
- Some projects have been revised as a result of additional information received during the Increment F and G study.

However, the appendix was not rewritten as a result of these revisions.

- New item numbers have been assigned to the projects of the final recommended plan. However, the G, GEC, and GECO designators from the draft report have been retained as reference numbers for traceability through the rest of this report, to the draft report, and to the 1391 documentation and planning already underway in Alaska District.

TABLE 3-1 FORT GREELY – INCREMENT A PROJECTS - BUILDINGS

ITEM	ECIP PROJECT NO.	PROJECT	PROJECT LOCATION	FY '83 PROJECT COST ($ 000)	SOURCE ENERGY SAVINGS (MBTU/YR)	DISCOUNTED SAVINGS INVESTMENT RATIO	ENERGY/COST RATIO (MTBU/$ 000)	SIMPLE PAYBACK PERIOD (YEARS)	FY '84 ESTIMATED SAVINGS ($ 000)	SAVINGS ESTIMATE % FY'80 FUEL (626 x 10^9 BTU/YR)
1	GEC 1	Family Housing Lighting Improvements	FH	172	16,500	3.36 (3)	96	4.4	39 (1)	2.64
2	G2, 3, 4 GEC 3, 4	Lighting & Head Bolt Heaters	Various – Bldgs – Streets – Parking	431	35,829	2.1 (2) to 2.9 (3)	83	5.1	83.7 (1)	5.72
3	GECO 10, 6, 11, 13	Heating & Ventilation	23 Bldgs.	985	53,522	9.8 (2)	54	1.34	733 PARTIAL (1)	8.55
4	GEC 5 GEC 2	Family Housing Insulate Basement Walls & Pipes	FH	420	10,035	7.73 (3)	34	2.59	162	1.60
5	GEC 6	EMB Insulate Basements & Slab Edges	EMBs & BOQs	457	8,934	6.32 (3)	20	3.17	144	1.43
	ECIP	Total		2,465	124,820	N.A.	51	2.12	1,161.8	19.94

Fuel Costs:
Heating: Oil @ $16.14/MBTU
(1) Electric: Coal @ $2.34/MBTU (based on 24,500 BTU/KWH)

Recurring Benefits/Cost Factor:
(2) Based on 15 year Life:
Oil = 13.112, Coal = 10.798
(3) Based on 25 Year Life:
Oil = 20.050, Coal = 14.777

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TABLE 3-2 FORT GREELY INCREMENT B PROJECTS – DISTRIBUTION SYSTEM

ECIP PROJECT NO.	PROJECT	PROJECT LOCATION	FY '83 PROJECT COST ($ 000)	SOURCE ENERGY SAVINGS (MBTU/YR)	DISCOUNTED SAVINGS/ INVESTMENT RATIO	ENERGY/COST RATIO (MTBU/$ 000)	SIMPLE PAYBACK PERIOD (YR)	FY '84 ESTIMATED SAVINGS ($ 000)	SAVINGS ESTIMATE % FY'80 FUEL (626×10^9 BTU/YR)
GEC 7	Insulate Steam Supply Lines	Steam Distr.	490	11,300	7.4 (3)	23	2.7	182	1.805
GECO 12 GECO 9	Misc. Flanges and Fire Hydrants								

Fuel Costs:

Heating: Oil @ $16.14/MBTU

(1) Electric: Coal @ $2.34/MBTU (based on 24,500 BTU/KWH)

Recurring Benefits/Cost Factor:

(2) Based on 15 Year Life:
Oil = 13.112, Coal = 10.798

(3) Based on 25 Year Life:
Oil = 20.050, Coal = 14.777

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TABLE 3-3 FORT GREELY – INCREMENT F PROJECTS - OPERATIONS & MAINTENANCE

ECIP PROJECT NO.	PROJECT	PROJECT LOCATION	FY '83 PROJECT COST ($ 000)	SOURCE ENERGY SAVINGS (MBTU/YR)	DISCOUNTED SAVINGS INVESTMENT RATIO	ENERGY/COST RATIO (MTBU/$ 000)	SIMPLE PAYBACK PERIOD (YR)	FY '84 ESTIMATED SAVINGS ($ 000)	SAVINGS ESTIMATE % FY'80 FUEL (626 x 10^9 BTU/YR)
G-1	Consolidated ImprovementProg Fluorescent Lighting	Basewide	31	6,860	5.6(2)	221	1.94	16(1)	1.10
GECO 15	Swimming Pool • Raise Air % RH&T • Lower Water T • Shut Fan Off For Longer Periods	503	-0-	2700	Infinit	Infinit	Zero	44	0.431
TOTAL			31	9560		308	.52	60	1.53

Fuel Costs:

Heating: Oil @ $16.14/MBTU

(1) Electric: Coal @ $2.34/MBTU (based on 24,500 BTU/KWH)

Recurring Benefits/Cost Factor:

(2) Based on 15 Year Life:
Oil = 13.112, Coal = 10.798

(3) Based on 25 Year Life:
Oil = 20.050, Coal = 14.777

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TABLE 3-4 FORT GREELY - INCREMENT G PROJECTS - MISCELLANEOUS

ECIP PROJECT NO.	PROJECT	PROJECT LOCATION	FY '83 PROJECT COST ($ 000)	SOURCE ENERGY SAVINGS (MBTU/YR)	DISCOUNTED SAVINGS/ INVESTMENT RATIO	ENERGY/COST RATIO (MTBU/$ 000)	SIMPLE PAYBACK PERIOD (YR)	FY '84 ESTIMATED SAVINGS ($ 000)	SAVINGS ESTIMATE % FY'80 FUEL (626 x 10^9 BTU/YR)
GECO 1	New Coal Central Heating & Power Plant 50,000 Lb/Hr @ 800 PSIG 3000 KW	-606	6,800	162,640	N.A.	23.9	2.01	3,380	25.981
	EMCS	-606	1,064	9,294	0.9*	8.7*	21.3	150 - 100 = 50	1.48

*DOES NOT MEET ECIP CRITERION

Fuel Costs:

Heating: Oil @ $16.14/MBTU

(1) Electric: Coal @ $2.34/MBTU (based on 24,500 BTU/KWH)

Recurring Benefits/Cost Factor:

(2) Based on 15 Year Life:
Oil = 13.112, Coal = 10.798

(3) Based on 25 Year Life:
Oil = 20.050, Coal = 14.777

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TABLE 3-5 FORT GREELY - PLAN SUMMARY

ECIP PROJECT NO.	PROJECT	PROJECT LOCATION	FY '83 PROJECT COST ($ 000)	SOURCE ENERGY SAVINGS (MBTU/YR)	DISCOUNTED SAVINGS/ INVESTMENT RATIO	ENERGY/COST RATIO (MTBU/$ 000)	SIMPLE PAYBACK PERIOD (YR)	FY '84 ESTIMATED SAVINGS ($ 000)	SAVINGS ESTIMATE % FY'80 FUEL (626 x 10^9 BTU/YR)
	A		2,465	124,820		51	2.12	1,161.8	19.94
	B		490	11,300		23	2.7	182	1.81
	F		31	9,560		308	0.52	60	1.53
Sub Total	A, B, F		2,986	145,680		48.8	2.13	1403.8	23.27
	G W/O EMCS		6,800	162,640		23.9	2.01	3,380	25.981
Total	A, B, F, G		9,786	308,320		31.5	2.05	4,783.8	49.25

Fuel Costs:

Heating: Oil @ $16.14/MBTU

(1) Electric: Coal @ $2.34/MBTU (based on 24,500 BTU/KWH)

Recurring Benefits/Cost Factor:

(2) Based on 15 Year Life:
Oil = 13.112, Coal = 10.798

(3) Based on 25 Year Life:
Oil = 20.050, Coal = 14.777

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Section 4
BASEWIDE RECOMMENDED PROJECT

This section covers Increment A & B projects entered in the plan. Increment F & G items are covered in section 5.

In this section the groups are divided into electrical conservation projects, all Increment A, and steam conservation projects of the both Increments A & B.

4.1 ELECTRICAL ENERGY CONSERVATION PROJECTS

4.1.1 General Discussion

Site visits and examinations of various buildings and facilities at Fort Greely, have resulted in an assessment of electrical energy flows, utilization, and consumption.

Significant improvements are attainable in lighting systems and resistance heating (in the form of automotive engine block heating in winter). These recommendations for improvement are typically generalized due to the enormity of providing detailed installation designs for numerous locations and unique conditions. Motor loads have been identified and reported under Mechanical Systems as fan, pump, compressor, and other loads. As such, any fan or pump load reduction will automatically reflect a proportional reduction in the motor drive.

To assign a reasonable cost/KWH of energy, a thermodynamic balance and rate analysis was performed based on energy reductions occurring at the marginal heat rate of 24,500 BTU/KWH of coal consumed at Fort Wainwright without useful heat recovery. On this basis, we estimate 5.1¢/KWH (FY'79) to be reasonable as a true cost of electricity. However, for fuel cost savings only, a value of 3.565 ¢/KWH (FY'79) was used. This was escalated at 10% annually as indexed to coal price forecasts. Estimates for project installation costs were based on FY'79 figures, with annual 6% escalation to the construction year.

Simple paybacks were computed on a basis of FY'83 installation cost with FY'84 as first year's savings.

4.1.2 Recommendations

Six recommendations for electrical energy conservation are identified. These are as follows:

- Lighting Improvement - Enlisted Men's Barracks (G-2) - Incandescent lighting fixtures should be replaced with fluorescent fixtures in corridors, entries, toilets, and closets. Approximately 40 watts of fluorescent lamps will replace two 60-watt incandescent lamps.

- Exterior Lighting Improvements (G-3) - The outside lighting system utilizes mercury vapor luminaires. Replacement and conversion to HPS lighting will reduce energy comsumption by an estimated 40%, which will save 0.1 million KWH annually. This does not include any savings already realized by the on-going Fort Greely energy conservation program.

  To reduce initial cost, conversion of mercury vapor luminaires to HPS, rather than replacement of the luminaires, is recommended. Thus, the existing fixture and ballast would remain intact. A conversion kit would include an HPS starter assembly, capacitors, new lamp, and a socket extender.

- Consolidated Lighting Improvement - Hangar Facilities (G-4) - The support areas of hangar T-100 are typically illuminated with incandescent lamps and should be replaced with fluorescent fixtures. In this application, the evaluation is based on using a 40-watt fluorescent lamp to replace three 50-watt incandescent lamps.

  The hangar main floor utilizes mercury vapor illumination. These lights were found to be on for 12 to 14 hours per day, much of the time unoccupied. It is recommended that the existing luminaires be replaced with lower wattage High Pressure Sodium (HPS) lamps reducing energy consumption by 40% while increasing the general illumination level.

- <u>Head Bolt Heater (HBH) Energy Reduction</u> (GEC-3) - The average vehicle engine heater utilizes 600 watts and frequently plugs into uncontrolled or temperature switched receptacles, accounting for an estimated annual consumption at Fort Greely of over 1 million KWH. This level can be reduced by almost 70% by using a power proportioning device at each receptacle cluster. It would be thermally sensitive, reducing throughput from 600 watts at -50°F to zero power at 10°F outside air temperature.

  In addition it is recommended that Fort Greely:

  - Promote the use of battery heat-pads and insulated covers to enhance cranking power
  - Promote the need for properly tuned and winterized engines
  - Investigate development of inexpensive automobile wind breaks or protection

- <u>Conversion to HPS Lighting</u> (GEC-4) - Many shops, warehouses, utility buildings, plants, service facilities, and food services currently utilize incandescent lamps in open type luminaires. The incandescent lamps (with efficacy of 20 Lumens/watt) are relatively short-lived and frequently poorly maintained resulting in lighting levels of 10 to 20 footcandles. Most such areas have ceiling heights in the 12 to 20 ft range.

  A program of replacement with HPS low-glare sealed luminaires, specifically suited for low bay installations, is recommended.

  This type of installation will result in:

  - Better lighting with 60-70% energy reduction
  - Far longer lamp life

- Better system lumen depreciation due to luminaire dirt reduction and more favorable lamp characteristics.

o <u>Lighting Improvements to Family Housing</u> (GEC-1) - Family housing accounts for over 2.7 million KWH/yr, or approximately 22% of the total Fort Greely electric consumption. The incandescent lighting consumption in the dining room, three bedrooms, and basement, which accounts for one million KWH/yr, could be reduced significantly by use of fluorescent fixtures. The resulting savings of 0.75 million KWH offers attractive eco-onomics and energy savings.

4.1.3 Conclusions

The electrical savings covered here were derived from analysis of prime targets for energy conservation. These users consume 39% of the 13 million KWH consumed annually within Fort Greely. A savings of 2.1 million KWH is anticipated, or almost 17% of the total consumed electric energy. When implemented, the total electrical consumption of the Fort would be reduced to some 10.8 million KWH (assuming zero growth).

The six recommendations offered herein provide a major share of the attainable electrical consumption reductions. Virtually all of the buildings of Fort Greely offer some potential energy reduction through use of higher efficiency light sources and reduced or controllable "on-times".

4.2 STEAM ENERGY CONSERVATION PROJECTS

4.2.1 General Discussion

In the search for steam conservation, both distribution and users were surveyed. In the course of this survey, the CH&PP also became subject for a recommended Increment D study since the potential for savings there is significant.

In the study of the steam distribution system, it was found that there are considerable savings opportunities in the installation of additional insulation.

Most of the ECIP implementation effort accomplished to date has been in the user buildings. The two most significant accomplishments have been the installation of building insulation, including storm windows and doors, and the installation of heating controls. The full potential savings from the additional insulation have not been realized, however, since the complex steam control problem (causing overheating) has not been fully solved, and since losses from excess ventilation overrides any potential savings from installed ECIPs.

4.2.2 Recommendations

The 10 recommendations for energy conservation in the steam area are as follows:

- Basement Piping Insulation (GEC-2) - The basements of the Family Housing units have many uninsulated heat sources. These consist of steam supply system equipment (in the mechanical equipment room), condensate return lines, and domestic hot water lines. For the warmer half of the year this heat loss to the basement represents a net energy penalty. All lines and components should be insulated. Some work in this area has been done. However, more remains to be accomplished. Specifically in 862, 863, 864, 887, 888, 889, 895, and 896 as a minimum.

- Insulate Basement Walls (GEC-5) - The well insulated family housing units lose almost 40% of their transmission heat through basement walls. It is recommended that these areas be insulated. Determination of the best method of insulation needs further evaluation in order to define the most practical and cost effective method of installation. Also, for buildings with some basement insulation, evaluation of methods of applying additional insulation is recommended.

- Insulate Basement Walls and Concrete Floor Edges (GEC-6) - The barracks lose about 40% of their transmission heat through the basement walls and from the concrete floor slabs joining to the external walls. The basement walls present the same problem as the GEC-5 project for Family Housing. These walls should be insulated in addition to the concrete floors. The floor to wall loss has several additional alternate insulating approaches. External insulation is preferred.

- Reinsulate Steam Supply Piping (GEC-7) - In the steam distribution system, the high temperature steam supply lines represent most of the distribution system heat loss. These pipes are underinsulated according to new Army standards. The validity of these new standards is confirmed by life cycle cost analysis. It is recommended that additional insulation be added to these supply lines.

- Insulation of Uninsulated Steam Lines and Flanges (GECO-12) - There is a small portion of the steam distribution system where there are uninsulated flanges. These account for a disproportionate heat loss. It is recommended that these areas be insulated when the steam supply line is reinsulated (GEC-7). The extra cost is within the allowed budget.

- Steam Tracer Automatic Shutoff Valve (GECO-9) - Conventional steam tracer lines were not found at Fort Greely. The distribution system served as the freeze protection. At the main Fort, the condensate return line is used to heat fire hydrants. It may be impractical to add a bypass line and thermostatic valve to shut off the hydrant heating in the summer.

  It is recommended the fire hydrants and riser water pipe be insulated as well as practical. This will cover 90% of the surface loosing heat and greatly decrease this fixed heat loss. Insulation must be of a closed cell type to tolerate water and must have a protective cover. This project should be made part of GEC-7 for the re-insulation of the steam supply lines. This extra cost is within the allowed budget.

- Heating and Ventilating (H&V) System - Several types of H&V systems are currently in use; fixed and modulated return air systems, and 100% outside air systems with heat recovery on the larger systems. A consistent cause for excess heating was too much outside air flow and wasteful system control logic. The amount of outside air for ventilation was very high, in the range of ten times the required rate. Three barracks and the Gym account for over 50% of all the ventilation at the Fort. There is a major need for understanding and consistency in the energy implications of the H&V design details. Then it is possible to settle on standards and documentation that will maintain some degree of system standardization.

It is suggested the effort should concentrate on reducing design point outside air ventilation, vary ventilation with building occupancy and use controls that do not cause simultaneous heating and cooling.

- Reduce Ventilation - Outside Air - A way to accomplish this reduced ventilation is to re-evaluate the design point for each building based on present usage; accounting for a diversity factor since the same people can't be in several buildings at the same time. Determine the present actual maximum occupancy, then allow the American Society of Heating, Refrigeration & Air Conditioning engineers (ASHRAE) standards minimum required outside air ventilation per person. This will result in the required ventilation for the seldom experienced maximum occupancy, and excess ventilation at other times. When all the other recommended control modifications are made, much higher outside air flows rather than the minimum will be used much of the time. The total air flow may also be capable of being reduced for a fan power savings. That detail needs study as part of an overall air distribution evaluation, and the desire to use the total air flow capacity to assist in summer cooling.

- Convert H&V to Demand - Control (GECO-13) - Two control causes of excess heating in the H&V systems were found. First, many systems used a fixed supply air temperature sensor set at about 70°F to regulate the heating coil, or to regulate the bypass air flow around the heating coil. Second, mixed outside and return air flow is regulated by a duct sensor trying to maintain about 55°F for the mix of outside and return air.

The first, supply air sensor, results in heating the air even when the conditioned space doesn't need heating. The supply thermostat should be moved to the return air duct or conditioned room, thus providing heating only when the room temperature drops. The second, mixed air sensor, results in too much outside air being used during the heating season, thus resulting in a very large heating penalty. The mixed air duct thermostat control should be handled in sequence with the above return air thermostat or existing room thermostat.

- <u>Full, Partial/Unoccupied H&V Time Clocks and 2-Speed Motors</u> (GECO-10, 11) - A major part of the energy penalty is caused by providing design point occupancy levels of ventilation during partial and unoccupied periods. Two approaches are recommended. One involves shut off, and the second, use of variable air flow. Shut off is the most cost effective and should be used on most of the smaller H&V units where a well-defined work schedule is known. Variable speed fans are reasonable for large H&V units serving areas with large variations in occupancy and erratic schedule.

  Shop and office areas controlled by 7-day clocks should be operated for an 8-Hour, 5-Day week basis, and off the rest of the time. Community services should be on for possibly 16 hours for 6 or 7 days and off at night. Barracks living areas should normally be on 24-hours per day, but the work and office areas could be scheduled off at night.

  Areas with large occupancy variations such as barracks, gyms, theaters, etc. should consider use of 2 or multi-speed motors controlled from a central energy management system. Local override control should be included with central monitoring for visibility. Barracks have a normal routine with partial daytime occupancy and full night occupancy, together with mission related unoccupied periods. The fan speed schedule must be under the supervision of a military office for the barracks so previous problems with shut-off periods are not repeated. Community service areas are easier to schedule for off and partial fan speed times. An override timed switch can be used locally to handle occasional full occupancy cases.

4.2.3 Conclusions

The savings anticipated by implementation of these steam saving items is 86.5 x 10^9 BTU/yr (source) or approximately 29% of the FY'80 Fort Greely oil consumption.

Section 5
INCREMENT F&G RESULTS

The Increment F&G portion of this contract was formalized after submittal of the Basewide Studies Final Report Draft. One task to be done at this point was to make recommendations relative to open items "GECO" list published in the draft report. Many of these GECO candidates have been incorporated into the Steam Energy Conservation Recommendations of section 4.2. The remainder of the GECO items are discussed here along with some other candidates identified in the course of F&G studies.

5.1 INCREMENT G ITEMS

Two items are entered in the Increment G Category as judged not to meet ECIP criteria. Brief descriptions of these items are as follows:

- Coal Fired Cogeneration (CH&PP) GECO-1

  This recommended project has been included in the Fort Greely long range plan. Although study of this project is beyond the scope of this contract, its impact on the energy plan is too significant to ignore. It has been entered into the Increment G category because a Phase D study is required before a firm size and cost can be established. The cost and oil savings potential are indisputable as a result of fuel switch from oil to coal. A strong economic argument can be made for a much smaller plant.

  It is suggested that three small 800 psig boilers with a total capacity of 50,000 lb/Hr of steam and 3000 KW capacity turbine generators be installed. This $6.8 million installed system would use some of the present system as back up.

Replacing the present capacity would cost $18.3 million. Present capacity of 150,000 lb/Hr of steam and 5500 KW diesel generators exceed the present demand. Three small boilers at about 17,000 lb/Hr each would meet the present use profile much more effectively. Most of the demand can be met with 1 to 2 boilers with an occasional requirement for the third unit. The three existing 50,000 lb/Hr oil fired boilers should be sufficient for back up. New turbine generators with 3000 KW total capacity would provide 75% of the power requirement with the remaining power supplied by the present tie line to Fort Wainwright.

- Energy Management and Control System (EMCS)

  A requirement for Increment B of this contract was to develop an EMCS System for Fort Greely to the Tri-Services NAVFAC Type Spec TS-13941-6. This project was evaluated and found not to meet ECIP criteria and so is listed as an Increment G project.

  This EMCS project is not recommended for Fort Greely for the following reasons:

  - Automatic energy conservation control modifications can be readily implemented with local control such as programmable controllers or smart clocks. These systems are simpler to maintain and would provide a significant part of the savings anticipated from an EMCS.
  - The state of the art for EMCS is presently undergoing significant changes. New government specifications are influencing the industry. Much trial by fire is being experienced in systems recently installed and expectations are not being realized. Problems in software, maintenance, instrumentation, and reliability abound.
  - The remoteness of the Fort and the inherent difficulties in obtaining replacement parts and prompt, good technical support must be considered.

A Johnson Controls JC-80 EMCS system was installed in 1980, but as of Nov. '81 was no longer in use. This is cited as further evidence that Fort Greely is not yet ready for an EMCS. Apparently the needs and identity of the user had not been adequately defined and the system was misapplied.

It is recognized that an EMCS could be a useful tool to a person trying to manage energy usage at Fort Greely, especially by providing useful management information. Installation of such a system would require formalization of the energy management and control function and training of operators to run the system. It is conceivable, but not apparent, that this activity could be an asset. We recommend that prerequisite to the installation of an EMCS should be the installation of an on site energy manager/controller who has determined on a practical day-to-day basis what can be and is to be controlled, and whether an EMCS would be of any use in his job of controlling energy. This study shows how to reduce energy usage by 23% without an EMCS. Further potential saving by an EMCS cannot justify the high cost of the system. However, the energy management and control function is legitimate and should be implemented by personnel rather than systems at this stage of development.

5.2 INCREMENT F ITEMS - O&M PROGRAM

A general opinion is that Increment F Category E.C. Items falling within the Facilities Engineering budget have too much competition for funding and as a consequence will not get implemented. Therefore, where possible, such items have been consolidated into ECIPs to raise the potential for accomplishment. There are, however, things that can be done best on an on-going basis under local control. The scope of these items cannot be totally defined or budgeted for, but guidelines can be set so problems can be identified and resolved when they are found. It is suggested such a local program can be successful with the provision of knowledge, manpower, and funding with accountability.

This report with its recommendations, and especially its background technical discussion, is a first step in providing some of the knowledge required, supplemented with E.C. training as it is available.

Further, in order to better implement the energy management function, it is recommended that dedicated funds be allocated for use by a small part of the Facilities Engineering organization, where energy management and conservation would be a primary role not diluted by other maintenance duties. Along with this function should be resources, authority to take action, and accountability for producing results in setting, attaining and maintaining target energy reductions.

A reasonable starting budget for such a function would be about 2% of the energy budget. A dedicated, energy conservation trained, engineer is seen as a full time requirement to identify problems and appropriate solutions, and direct corrective action with priority access to maintenance manpower required to take action. An implementation fund is also necessary. An estimated $50,000/year material budget with an engineer and the equivalent of two mechanics is suggested as a starting point to explore this means to sustained energy cost savings.

Training in energy conservation is also seen as a necessary step for managers, supervisors and engineers, and possibly selected mechanics. Unfortunately, useful training with an E.C. focus is not too widely available. There are too many diverse subjects that must be covered in some depth. In addition each facility tends to have its own unique set of problems, thus general courses don't always apply. On the job experience at solving these problems is probably the best supplement to available training.

Implementation of the recommended ECIPs are a necessary prerequisite to maximum E.C. at Fort Greely. However, the full potential cannot be realized from that alone. It needs the sustained O&M activity as well. There are some significant actions that can be taken, even before the ECIPs are in place, to attain a portion of the potential savings. Reading of the technical discussions on the various ECIPs will provide background knowledge and insight to supplement the following list of recommended Increment F, O&M actions.

- <u>Fluorescent Lighting Improvement Program</u> (G-1)

  Improvements recommended include relamping and reballasting with power saver alternates at the time that existing components require replacement due to failure. Group lamp replacement is also recommended over spot lamp replacement, since it is more economical, maintains more even illumination, and permits a higher design Maintenance Factor (MF). Thus, 10-15% fewer lamps may frequently be installed while maintaining the same average illumination as compared to spot replacement. This is considered to be an O&M type program.

- <u>Swimming Pool E. C.</u> (GECO-15)

  It is recommended that swimming pool temperatures, humidity and hours of fan operation be carefully set to minimize operating cost while maintaining comfort for the swimmers. This can be accomplished by setting conditions that limit the water evaporation rate from the pool surface and the swimmers skin. Specific recommendations are:

  - Air humidity, 60% RH or preferably above
  - Air temperature, 80°F or preferably above
  - Water temperature, 80°F or preferably below
  - Fan operation, limited to normal occupancy hours and off whenever pool is not to be occupied.

  Pool operating costs are estimated at $44,000/year operating at the numerical values given above. Cost could range from 1/3 to 4 times that value and remain within the pool design criteria envelope for pleasure swimming conditions. It is therefore important to understand the energy implications of pool operation and set controls accordingly.

o <u>Interim H&V Program</u>

A major ECIP for Fort Greely is modifications to the H&V systems as discussed in section 3.3. Some of the savings to be attained by this program could be made by the Facilities Engineer in the interim, while waiting for implementation of the ECIP. A dedicated team of an E.C. knowledgeable engineer directing the appropriate mechanics could probably accomplish this program with 1 to 2 man years of effort. The low cost items that should be done by this method are:

- Reduce fan speeds by a sheave change. Since excess air flow is so generally the case, the exact amount of reduction is not critical, it could be whatever is practical. The fine tuning would come later after ECIP engineering is complete.
- Calibrate controls of set point systems. Lower supply set points until occupants complain. Settings can be lower in summer than in winter. Raise mixed air set point to eliminate heating in moderate weather.
- Where possible, move the set point control thermostat from supply duct to return duct. This will set the system up as a demand system where comfort and savings can be automatically maintained under varying load conditions.

The exact savings of this program are not predictable, however, the potential is large.

o <u>Continuous Heating Control Program</u>

Once ECIPs are implemented or interim programs are accomplished there is an on-going requirement to maintain controls in calibration and repair, and to reset them as conditions change or they drift from the planned settings. It is recommended that this be done on a periodic basis. To illustrate, note the example of pins removed from a 7 day start-stop clock that left a fan motor running when it wasn't needed and for long periods of time. As long as a system is functioning its controls tend to remain untouched for years whether it is wasting energy or not.

- Steam Trap Maintenance

  Steam trap leakage is of continuous concern to energy conservation since it raises the temperature and thereby the continuous conduction loss of the condensate return system. It is, of course, of more importance in branches with no return. As an aid to steam trap maintenance it is recommended that color change, stick on patches (reversible wax type) be applied to all steam traps for immediate visual indication of trap leakage.

- Piping Insulation (GECO-2)

  Piping flange and valve insulation is covered by ECIP for the steam distribution and family home basement pipes. However, past experience has shown that such overall projects can be incomplete in their coverage. To cover such an oversight contingency it is recommended that maintenance be given an on-going task to upgrade missing, worn, damaged or deficient piping insulation as it is discovered in utilidors or buildings. The Facilities Engineer should be budgeted the means to correct these deficiencies since the action has been demonstrated as cost effective for the ECIP.

  Specific areas noted as uninsulated include:

Gym	- 503
	- M.E. room large flanges & valves
Barracks	- 659, 661, 663
	- Condensate return
	- M.E. room flanges & valves
Misc Bldgs	- Domestic Hot water return lines
	- Unit heaters
	- condensate return lines

- Domestic Hot Water Control Settings

  During the survey, some domestic hot water heater aquastats were observed to be set too high, even beyond the 140°F domestic upper limit specified for safety reasons. Generally 110° - 120°F settings are adequate for washing purposes. Therefore that setting is recommended for hot water heaters except where there is a specific requirement for higher temperature, as may be found in kitchens.

- Thermostatic Valve Control - (GECO 3, 4)

  There were several unit heaters and radiators that did not have thermostatic valve control to shut off steam to these units. These all need thermostatic control to prevent over-heating and energy waste during moderate weather. A common problem is freeze up of these units in exposed locations such as halls and entry ways.

  It is recommended that the unit heaters have a steam line valve controlled in sequence with the thermostatically con-trolled fan. An override is required for freeze protection that will sense freeze conditions and maintain steam on the coil (Ogantz Valve). In a similar manner unit radiators in entry ways must have fail open valves.

- Incandescent Lamp Reduction (GECO-8)

  It is recommended that an ongoing O&M program be established to replace incandescent bulbs with fluorescent fixtures wher-ever practical. Generally this implies bulbs that remain on for one or more shifts per day. One watt of fluorescent can replace 3 or 4 watts of incandescent for a significant overall electrical saving when the numerous locations are added up. This modification was recommended as an ECIP for Family Housing because it was possible to scope the job where the same conditions exist in many units. However in the military buildings the scope is difficult to assess because of the diversity of applications. Therefore it is best handled under on site control as an Increment F ongoing program.

- o <u>Lamp On-Time Reduction</u> (GECO-8)

  Excessive lamp on-time caused by lights on during periods of building or area non-occupancy may be responsible for an appreciable amount of lighting energy. Voluntary manual efforts to shut lights off appear to be effective at Fort Greely, however, there were conditions observed where lights were on when they didn't need to be. It is recommended that the on-site O&M activity include means to provide semi-automatic switching capability for areas where it would be appropriate.

  Two types of semi-automatic switching systems have been used with significant success and reasonable pay-back. Both timed switches that require manual turn-on with automatic turn-off and clock activated control where regular on times are in force can be effective.

- o <u>High Efficiency Electric Apparatus</u>

  It is recommended that replacement of failed electric apparatus be made using high efficiency equipment. Based on life cycle costing, the higher efficiency energy savings more than compensates for the premium price of such equipment. Specifically, replacement of motors, transformers and fluorescent ballasts should be done on this basis.

Section 6
PROJECTED RESULTS & PROGRAM IMPLEMENTATION

6.1 PROJECTED ENERGY USAGE

If all these recommended projects were implemented in FY'83, their estimated cost would be about $3 million and the first year savings in FY'84 would be about $1.43 million. The total annual source energy savings over FY'80 would be about 23% or 146 billion BTU/yr (5,840 standard tons of coal equivalent).

Figure 6-1 displays the projected profile of annual energy consumption at Fort Greely through FY'85, assuming successful implementation of the projects by FY'84, but without the new coal fired CH&PP which is considered external to the Energy Conservation Plan.

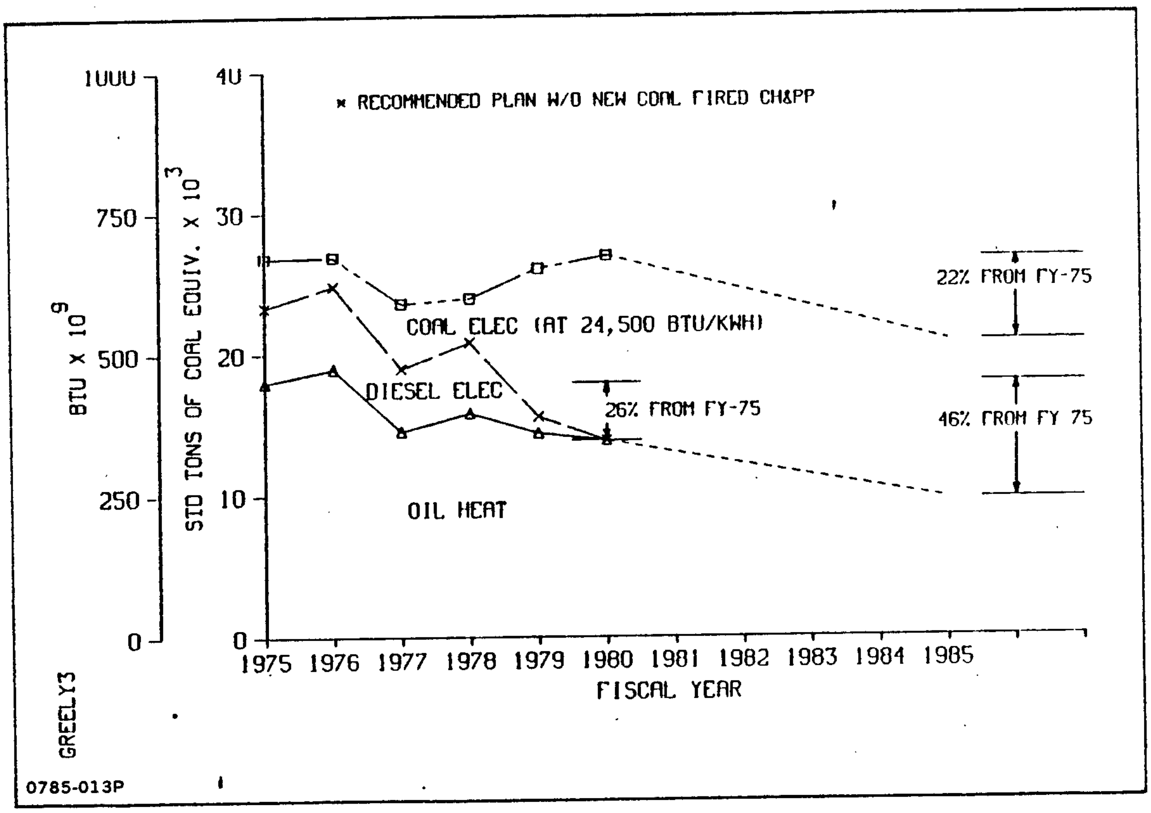

Fig. 6-1 Fort Greely Projected Annual Energy Usage

Figure 6-2 shows the projected energy performance improvement on an energy index chart. It is user oriented so the impact of the new CH&PP is not included.

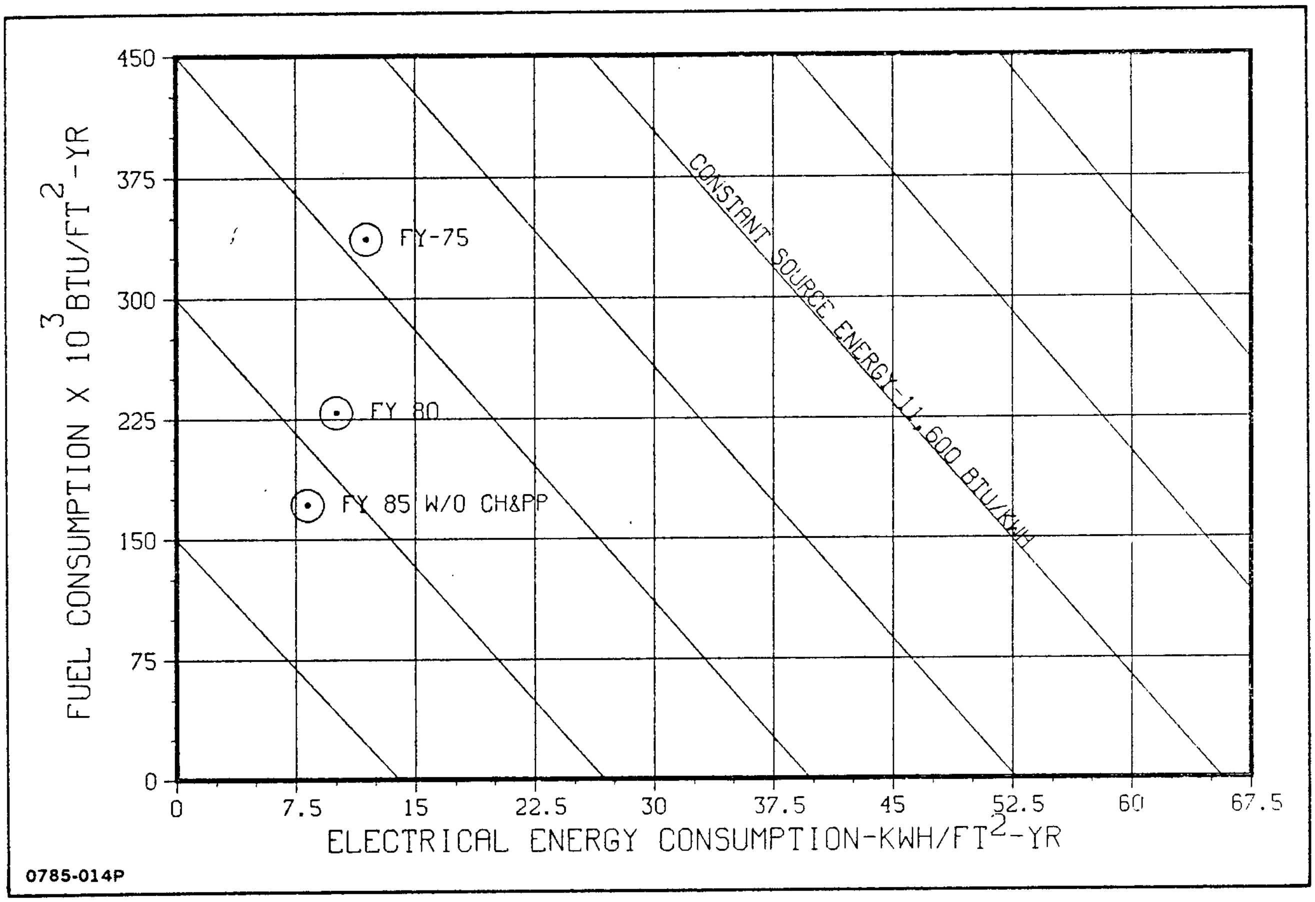

Fig. 6-2 Fort Greely Energy Index (FY'75-FY'85 Projection)

Figure 6-3 displays annual energy and dollar savings potential with implementation of the recommended plan, along with the ultimate potential with a recommended small coal fired CH&PP at Fort Greely.

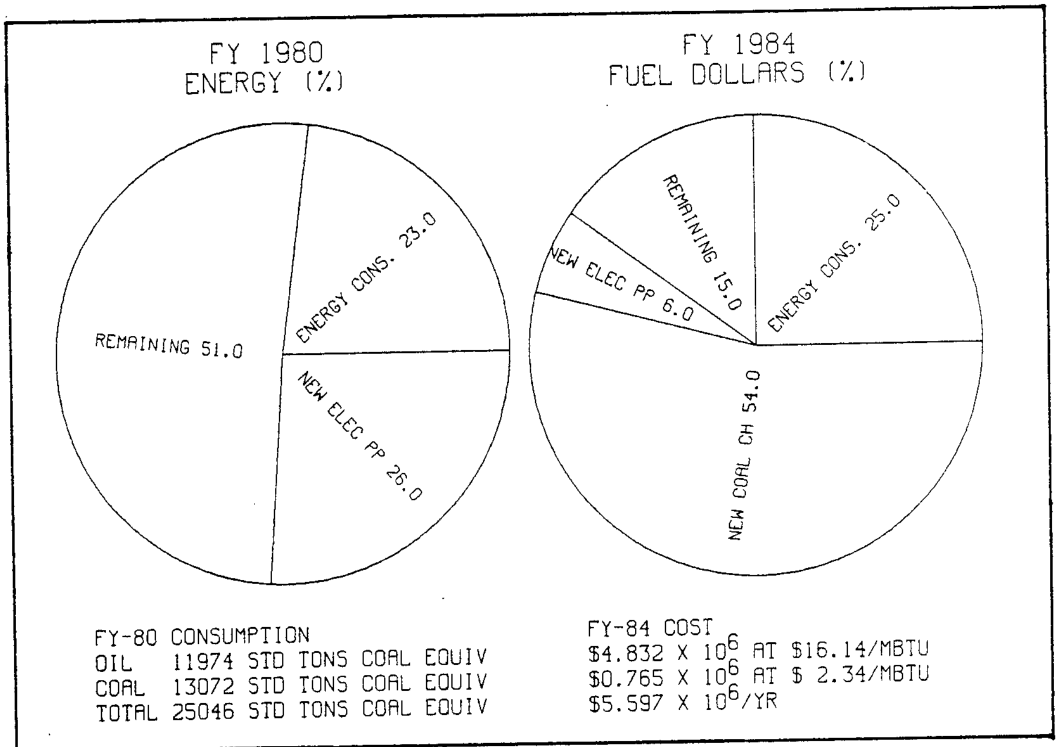

Fig. 6-3 Fort Greely Savings Potential

6.2 PRELIMINARY SCHEDULE

The recommended energy plan is a starting point for the evolution of the actual plan to be implemented. An Increment D CH&PP study will be an important input to the plan. A further engineering study may be desired before incorporation of low E/C or long payback items. Feedback on the rate of funding availability, as well as technical and administrative review, and concurrence with this and subsequent studies all enter into the plan evolution.

A simplifying assumption was made in this study that implementation costs were for FY'83 and first year savings were for FY'84.

This allowed for ranking of projects on an equal basis, but it is an unrealistic assumption for the final plan. The time required for engineering and implementation as well as annual funding limits will tend to spread the implementation over a longer number of years. The tentative schedule is outlined in Fig. 6-4.

This plan shows continuing study activity in FY'81, with possible start of quick fix implementation that will continue for several years. The ECIP implementation is spread over FY'83 and FY'84 with the prerequisite engineering time preceding it. This would provide a full first year saving in FY'85. Two other activities are shown as an essential part of an ongoing energy conservation program:

- Monitoring of energy consumption/savings on a continuous basis as a management feedback mechanism for spotting deficiencies
- Implementation of Increment F O&M procedures oriented towards improving and maintaining energy performance. Experience has shown that implementation of Energy Conservation Projects without a monitoring and maintenance program can lead to savings that tend to erode away with time.

6.3 RELATIONSHIP TO ARMY ENERGY PLAN

This Preliminary Energy Plan meets the objectives of the Army Energy Plan of 8 August 1980 with one exception. That plan sets objectives of 20% energy reduction in facilities by FY'85 from FY'75. The measurements are to be in terms of BTU/GSF performance index. This goal has almost been achieved with 21% savings at Fort Greely, and with the plan would achieve 41% by FY'85. The Army goal for the year 2000 is 40% of FY'75. This goal can be exceeded at Fort Greely by expanding this plan with CH&PP conversion.

The US Armed Forces Command (FORSCOM) performance target is 173,000 BTU/GSF-yr in FY'85. The projected Fort Greely performance is 267,258 BTU/GSF-yr by FY'85 based on average, 11,600 BTU/KWH, heat rate for electrical. Even if allowance is made for the high degree day bias of Fort Greely, this index is high.

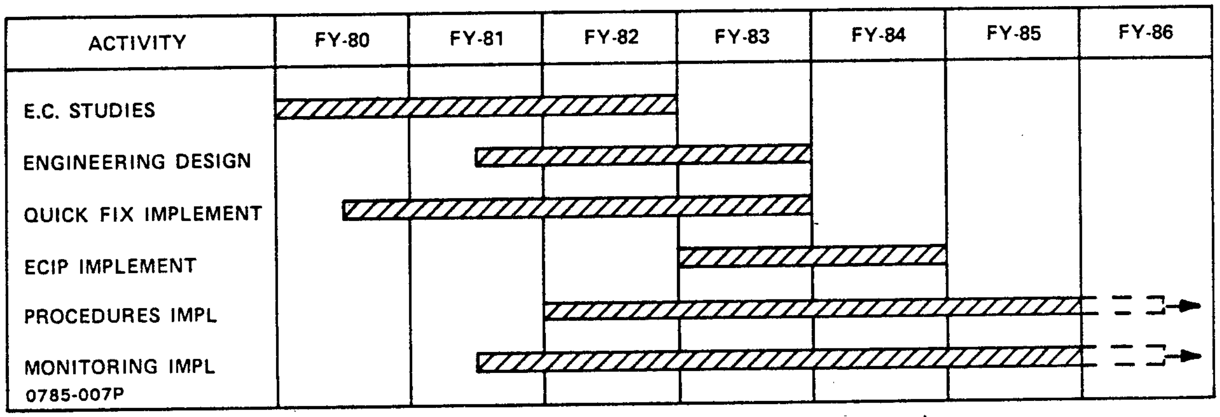

Fig. 6-4 E.C. Program Plan - Preliminary Schedule

The use of petroleum fuels for facilities at Fort Greely is extensive. Therefore, the Army goal of 75% reduction is applicable here. However, the transfer of coal generated electricity to Fort Greely does help oil reduction at that facility, and implementation of heat reduction elements of the plan will bring oil reduction to 60%. One way to meet the oil reduction goal is with a new coal fired CH&PP.

To meet the overall Army goals, it should be recognized that some installations will have to exceed the 20% and 40% targets because other facilities will not be able to make such a large percentage contribution, since they may have been more efficient to start with. Therefore, maximum feasible savings should be the overall goal for every installation.

In this section only an average heat rate of 11,600 BTU/KWH was used for measurement of progress against the plan to avoid an arbitrary penalty that would have been imposed by using the marginal heat rate of the Fort Wainwright plant used throughout the rest of this study. Fort Greely has made real progress to date in the energy usage reduction of 11% in electricity and 26% in heating.